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AGENCY: Montana State University

GRANT: Grouse Food, Pollinator, and Dung Beetle Ecology-Grazing

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Annual Report – March 2017

Grouse Food, Pollinator, and Dung Beetle Ecology - Grazing Evaluation

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Dung Beetles with Dung Ball - *Canthon pilularius* Copyright © 2005 Bryan E. Reynolds

Submitted by:

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EXECUTIVE SUMMARY

Our study sites are in two spatially separate locations in Montana; central and eastern. At each location, we are examining the effects of livestock grazing on the arthropod community as it relates to sage-grouse and sharp-tailed grouse management; however, our primary research objective is investigating, in the larger context, arthropod community structure associated with rangeland management. We are investigating two grazing programs. First, is the Natural Resources Conservation Service (NRCS) Sage-Grouse Initiative (SGI) rest-rotational program implemented in central Montana. Second, is the Montana Department of Fish, Wildlife and Parks (MT FWP) three pasture rest-rotation program implemented on the Buxbaum ranch in eastern Montana. Our field efforts this year consisted of collecting arthorpod community samples focusing on 1) ground dwelling grouse food items, 2) vegetation dwelling food items, 3) rangeland pollinators, and 4) dung beetles. Entomological work is tedious and requires weeks of laboratory dissecting scope time to process samples and identify all arthropods. We have completed processing a portion of our samples and here present preliminary results.

In total, we have collected 4 sets of arthropod samples (described above) at 21 locations over a 10-week period resulting in 840 samples. From previous sampling, we estimate these samples will yield approximately 20,000 specimens for identification.

In general, our results suggest grazing management may have large effects on vegetation structure and food arthropod communities. Lands enrolled in SGI grazing systems are managed for cow/calf production and are comprised primarily of sage-brush steppe habitats. The Lake Mason National Wildlife Refuge (LMWR) comprises three units, and livestock grazing was removed from the largest unit over a decade ago. During 2012-2015, vegetation and food arthropod sampling occurred in SGI grazed and deferred pastures and on the LMWR. Analysis of vegetation data revealed that LMWR lands were characterized by much higher litter cover and lower amounts of bare ground in addition to greater vegetation height than surrounding grazed land. A detrended correspondence analysis of Family level diversity of food arthropods between pastures in SGI grazing systems and LMWR lands also indicated that differences exist between these land use strategies.

Our results are also suggesting differences in arthropod functional groups as a function of livestock grazing. More specifically, lands that are idle from grazing contain higher relative abundances of predatory spiders and detritivores. Greater levels of plant detritus explain these differences in that with the removal of grazing, more plant thatch (dried growth from the previous growing season) predominates the landscape. This provides a food source for detritus consuming insects but also provides ambush sites for predatory Lycosid spiders. In areas with less plant detritus (i.e., livestock grazed areas), Gnaphosid spiders dominate the predatory guild.

Furthermore, our results suggest that dung feeding beetles are greater in number in livestock idle areas. At first this seems counter-intuitive in that dung feeding insects should be greatest in number in areas with abundant cattle dung. However, this is not the case, and we are interested in the cause of this as it may be due to pesticide residues in the cattle dung that cause dung feeding insect mortality and morbidity. Thus far, food arthropod abundance tends to be greater in livestock grazed pastures when compared to long-time idle pastures. We speculate this increase could be greater if dung beetle populations were more representative on agricultural lands since dung beetles are a major food source of grouse chicks.

BACKGROUND

Livestock grazing is a dominant pressure on most range and prairie lands in Montana and is capable of modifying wildlife habitat in either positive or negative directions. It is vitally important for rangeland health and conservation of bird species to understand how arthropod food webs are influenced by these dominant pressures. It is becoming clear that arthropods alone can successfully drive ecosystems and that they are vital to the survival of many other species including game and non-game birds. Therefore, it is vital to know, from the bottom up, how various grazing systems alter plant community structure which in turn alters the food resources and thermoregulations sites of arthropods. It is also of equal importance to know, from the top down, how grazing influences different predatory guilds of arthropods which, through hunting strategy alone, can produce a trophic cascade thus altering the arthropod community. Arthropods affect the detritus which in turn influences soil nutrients, which affects the vegetation, which impacts wildlife and their habitats. Our project is based on gathering data to elucidate a structural foundation of how, with in grazing systems, arthropods influence wildlife habitat.

Therefore, we are conducting two intertwined projects which investigate how livestock grazing influences arthropods important to both sharp-tailed grouse, sage-grouse, and song bird survival. Project 1 investigates the MT FWP recommended three-pasture rest-rotation grazing program as implemented on the Buxbaum ranch in eastern MT. Project 2 investigates the SGI rest-rotation grazing program as implemented on multiple private ranches in central MT by NRCS and private landowners.

Project 1: Sharp-tailed grouse. The sharp-tailed grouse (*Tympanuchus phasianellus*) is a wide-spread prairie grouse species of which two subspecies have been observed in Montana: the plains sharp-tailed grouse (*T. p. jamesi*) and the Columbian sharp-tailed grouse (*T. p. columbianus*). The populations of many subspecies of sharp-tailed grouse have declined in recent years or become extirpated in much of their historic range. These declines are due to habitat loss resulting from the conversion of native habitats to cropland, excessive livestock grazing, and conifer encroachment (NRCS 2007). Due to these population declines, the sharp-tailed grouse is protected in portions of its present range.

The Plains sharp-tailed grouse (*T. p. jamesi*) occurs primarily on private lands of the Great Plains east of Rockies, from central Alberta and southwestern Manitoba south to northern Colorado and Nebraska. Grazing management, such as season long grazing, which does not include rest/deferred periods of vegetation regrowth has been suggested as one of the causes for reductions in sharp-tailed grouse numbers (Kessler and Bosch 1982, Johnsgard 1983, Kirby and Grosz 1995). Considering this, a search of the scientific literature revealed that the specific effects that livestock grazing systems have on the Plains sharp-tailed grouse has yet to be evaluated. MT FWP manages sharp-tailed grouse through their Upland Gamebird Habitat Enhancement Program which includes setting up livestock grazing systems; therefore, a better understanding of livestock grazing is needed to address this gap in knowledge as it relates to the food insects of sharp-tailed grouse. Additionally, this research complements/supplements research occurring in central MT which is studying the influence of grazing on the sagebrush ecosystem (sage-grouse, insects, songbirds) and grouse management.

Project 2: Sage-grouse. Greater sage-grouse (*Centrocercus urophasianus)* populations have been in decline in the western U.S. since the 1950s (Connelly and Bruan 1997). Many factors similar to those implicated in sharp-tailed grouse declines have been highlighted as explanations of sage-grouse declines. Chick survival is one of the most important vital rates driving greater sage-grouse population growth (Taylor et al. 2012) ; however, the specifics of this vital rate is a poorly understood component of sage-grouse ecology (Guttery et al. 2013). Much research has been conducted on the selection criteria used by female sage-grouse when choosing a brood site (Drut et al. 1994, Sveum et al. 1998) and the results have provided a foundation for land management considerations aimed at improving sage-grouse habitat and ultimately recruitment of chicks (Connelly et al. 2000). However, the criteria that female sage-grouse use for habitat selection may not provide insight into the relationship between the site resources and chick and brood survival (Morrison 2001). The mechanisms which influence daily chick and brood survival need to be better understood and these data should be used to establish habitat management strategies that affect annual recruitment and, ultimately, sage-grouse populations (Gregg and Crawford 2009).

RESULTS BY OBJECTIVE. PROJECT 1: SHARP-TAILED GROUSE

1) Quantify the influence of the MT FWP three pasture rest-rotation grazing, deferred grazing, and season-long grazing on:

a) the relative abundance and diversity of ground-dwelling arthropods serving as food items for sharp-tailed grouse and other grassland associated avifauna.

Sample processing is nearing completion. Anticipated completion date of May 15, 2017.

b) the relative abundance and diversity of above ground and plant-dwelling arthropods serving as food items for sharp-tailed grouse and other grassland associated avifauna.

Samples are being processed. Anticipated completion date of June 1, 2017.

c) the relative abundance and diversity of wild pollinators.

Wild pollinators are the backbone of functional native habitats. We have begun collecting a novel data set to address multiple Montana pollinator issues. First, our work is the leading contribution to pollinators species identifications unique to Montana and the sagebrush steppe habitats. Montana has been informationally limited in terms of pollinator research with reference identifications, within the Montana state border, relying heavily on specimens collected from surrounding U.S. states and Canadian Provinces. We will be delivering a current and location specific set of specimens to the national pollinator initiative that will fill an informational gap specific to Montana.

Second, livestock grazing is a dominant land use in Montana, surrounding states, and Provinces and our research program is addressing the larger issue of how pollinators are influenced within the cow/calf production system. The foundation of our research program is

treatment based and focused on understanding the managerial applications of livestock production programs for healthy rangelands. Pollinators are a crucial component of healthy livestock production systems in that they provide necessary reproduction services to flowering rangeland plants. Plant diversity is not only a necessity of wildlife habitat, it is an economic necessity to combat profitability variation in rangeland based cow/calf operations.

Our current sampling has collected nine different groups of pollinators. Five families of Hymenoptera (Apididae, Colletidae, Andrenidae, Halictidae, Megachilidae), one family of Diptera (Syrphidae), and three families of Butterflies and Moths (Fig. 1). Hymenopteran pollinators are the primary pollinators on rangelands and we have presented total catches here as a function of sampling location. We have intentionally not presented data specific to grazing treatments because we have only sampled one year and consider these data too preliminary to make any recommendations regarding land management scenarios. Considering this, we are currently working on identifications of all samples to the *Genus* and *species* level; however, we have presented family level IDs here while we are completing the higher taxonomic level work.

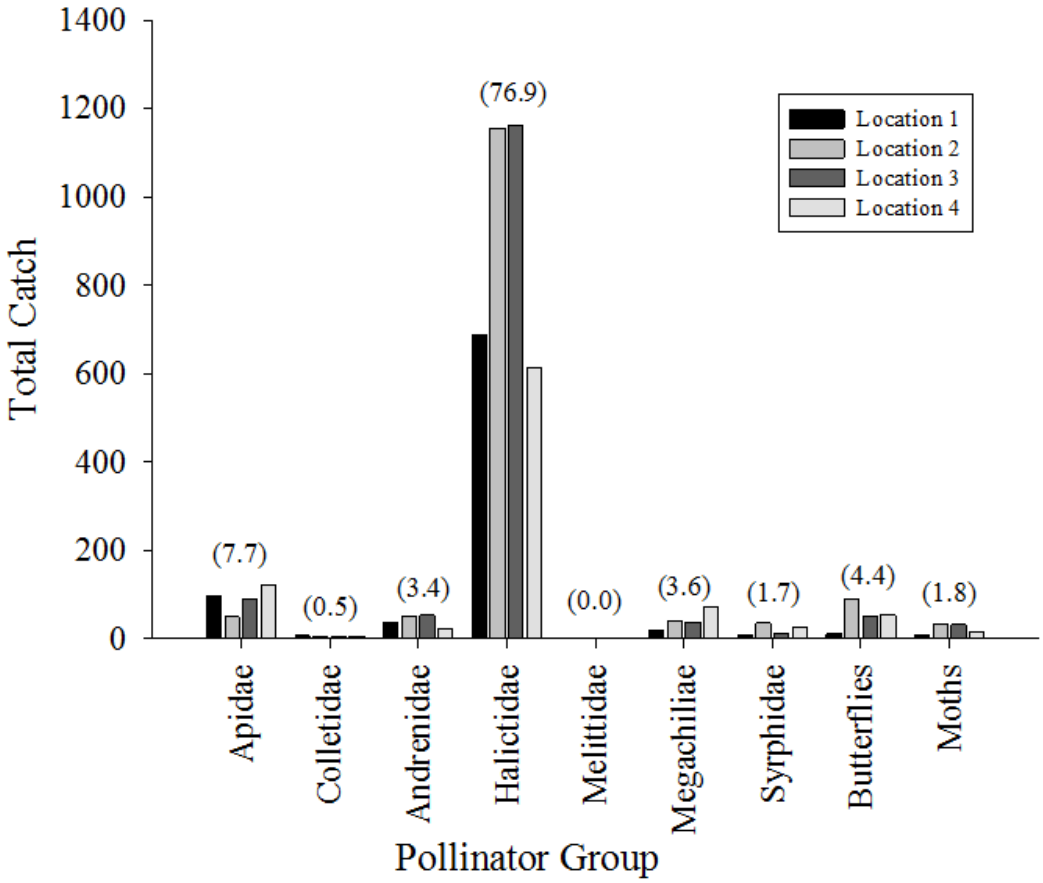

Figure 1. Pollinator captures by group from eastern Montana during 2016 as a function of grazing treatment.

From our collections, 76.9% (Fig. 1) of the total yearly catch were bees from the family Halictidae (Fig. 2) which is the second largest family of Apoidea bees. Halictid species are found all over the world and usually are dark green to black; often with a metallic appearance.

Members of the family Apidae (Fig. 3), which is the largest family of Apoidea bees in terms of the numbers of species (5,700 +), compromised 7.7 % (Fig. 1) of the total yearly catch. This family contains the most commonly seenn bees such as bumblebees and honey bees, but also less known groups such as carpenter bees, orchid bees, and cuckoo bees. As with halictids, many of these bees are important rangeland pollinators. Butterflies and moths, which were not identified to family, comprise 4.4% and 1.8% of the total catch, respectively (Fig. 1).

Megachilid bees (Fig. 4) comprised 3.6% of the yearly catch while Andrenid bees comprised 3.4% (Fig. 1). The Megachilidae are a cosmopolitan family in that most of their ranges extends across most or all global habitats. Megachilid bees are unique in that their pollen carrying structures, called scopa, are limited to the ventral surface of their abdomens, rather than the hind legs, as is exclusively the case with other bee families.

The Andrenidae (Fig 5), which are commonly called mining bees, comprised 3.4% (Fig. 1) of the total yearly catch. Mining bees are a diverse and nearly cosmopolitan pollinator family which nest on the ground and are solitary in habit, except during mating. They are located primarily in arid, steppe like habitats like the western U.S.

The Colletidae (Fig. 6) family are called Plasterer bees because they use mouthpart secretions to 'smooth' or plaster the inside walls of their nest cells with a cellophane-like lining. They are mostly found in South America and Australia with a few species in Montana. Members of the Colletidae compromised 0.5% (Fig. 1) of the total catch in our samples.

The Melittidae (Fig. 7), not captured in our 2016 sampling (Fig. 1), is a small family with a limited distribution. Melittids are small to moderate sized bees specializing in their oligolectic foraging habit which specializes in pollen preference from typically one genus of flowering plant.

Order Diptera (Flies) contains one specialized and important family of fly rangeland pollinator. Hover or Syrphid flies (Fig. 8) compromised 1.7% (Fig. 1) of the total yearly capture and represent the single Dipteran family of pollinators. Hover flies have evolved to mimic bee pollinators (Order Hymenoptera) in appearance, which is a form of Batesian mimicry where non-dangerous insects are selected to appear like dangerous specimens to 'capitalize' on visual similarities. Unlike the Hymenopteran bees they mimic, Hover flies cannot sting, regardless of their appearance.

Fig 2. A Sweat bee, family Halictidae.

Fig. 3. A bumble bee, family Apidae

Fig. 4. A leaf-cutter bee, family Megachilidae, showing abdominal scopa

Fig. 5. A Mining bee, family Andrenidae

Fig. 6. A Plasterer bee, family Colletidae

Fig. 7. A Melittid bee, family Melittidae

Fig. 8. A Hoverfly, family Syrphidae

d) the relative abundance and diversity of dung beetles.

Sample processing is nearing completion. Anticipated completion date of May 15, 2017.

e) the vegetative community biomass and diversity and percent bare ground (so that we have vegetative data specific to our sampling locations which will complement other veg data).

Completed for 2016.

RESULTS BY OBJECTIVE. PROJECT 2: SAGE-GROUSE

1) Quantify the influence of the NRCS SGI rest-rotation grazing and non-SGI season long grazing on:

a) the relative abundance and diversity of ground-dwelling food arthropods at sage-grouse nesting and songbird survey locations.

Our current sampling focus to meet this objective is on collecting those arthropods considered 'food items' of sage-grouse chicks. Our multi-year (2012-2016) data collected to date, suggests grazing management does influence the arthropod community structure. For example, private and public lands enrolled in NRCS SGI grazing systems are managed for cow/calf production and are comprised primarily of sage-brush steppe habitats. The Lake Mason National Wildlife Refuge (LMWR), which is located adjacent to the central Montana sage-grouse core area on which the NRCS SGI rest-rotation grazing program is implemented, comprises three units on which livestock grazing has been removed for over a decade. Samples targeting food arthropods, including 2016 collections, in SGI grazed and deferred pastures and on the LMWR is suggesting different arthropod communities associated with differing land management programs.

A detrended correspondence analysis of Family level diversity of food arthropods between pastures in NRCS SGI grazing systems and LMWR lands also indicated that differences exist among arthropod communities in different land use strategies (Fig. 9). We are recording differences in the community structure of arthropods that are considered grouse food items, which is most likely associated with the vegetative structure and detritus levels associated with the different land management programs. Our sampling efforts are also capturing arthropods which are important to songbird survival and will be incorporated into our final analyses.

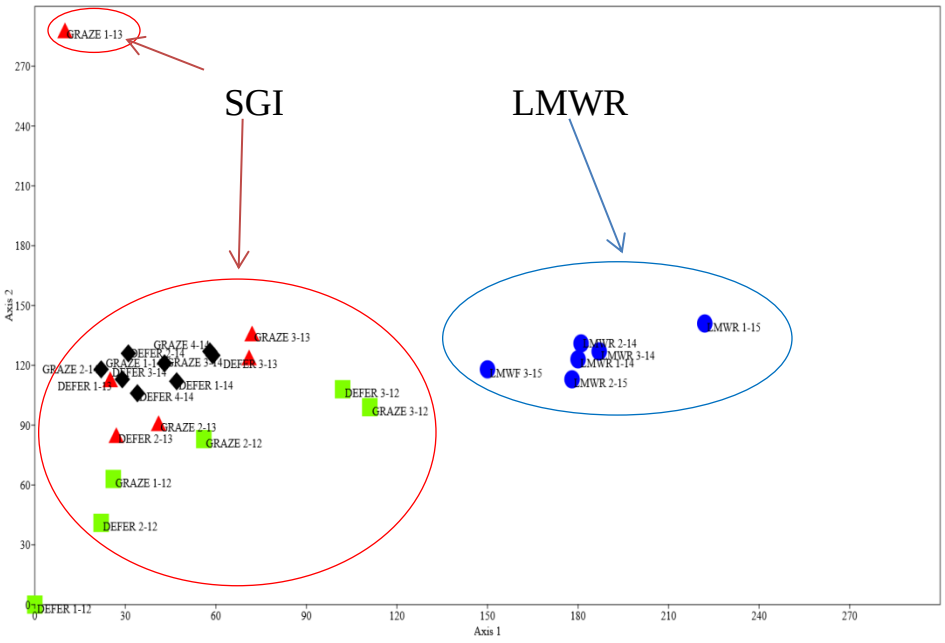

Fig. 9. Detrended Correspondence Analysis of data collected from Sage-Grouse Initiative (SGI) grazed and deferred pastures and the Lake Mason National Wildlife Refuge (LMWR). The diversity of arthropods collected from SGI and LMWR locations differ; possibly as a function of the differences between bare ground and plant litter.

For example, we are seeing higher levels of predator spiders and detritivores associated with the LMWR. When wolf spider (family Lycosidae) abundances from SGI properties are contrasted against catches from the LMWR, we see that more of these Lycosid spiders are associated with LMWR (Fig. 10). Due to the lack of grazing, vegetative thatch represented 65.4 $\pm$ 15.9 % of our sampling locations on the LMWR compared to only 12.6 + 6.3 in SGI pastures. Wolf spiders (Fig. 11) are positively associated with higher density thatch habitats. It is unclear at this point how this may affect the abundances of arthropods considered as food items of sage-grouse.

Detritivores, such as Hister beetles (Fig. 12) are also positively associated with areas containing higher vegetative detritus. More detritivores, such as Hister beetles, were captured on the LMWR in association with the higher levels of vegetative thatch. One detritivore group of importance are dung beetles. Dung beetle adults can feed on detritus, while the larvae are dung obligates.

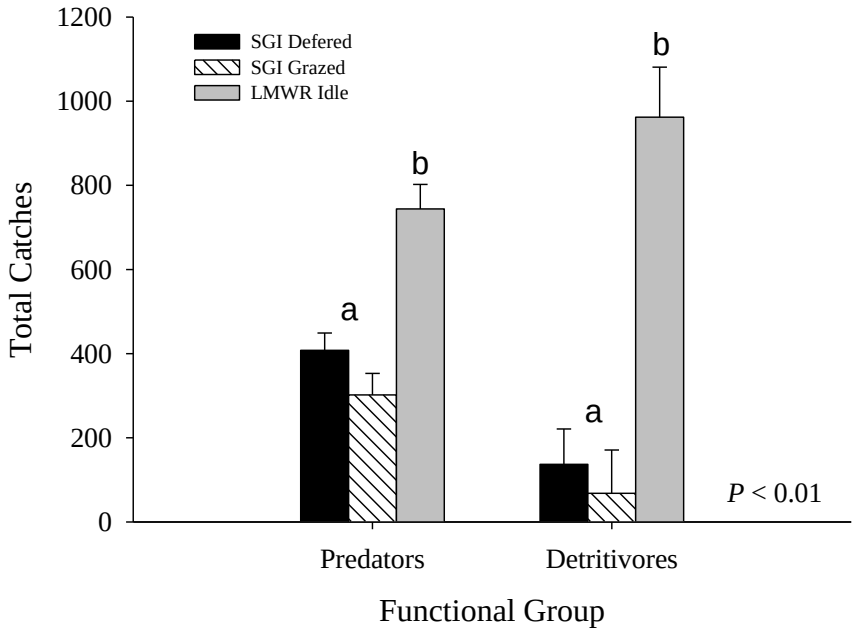

Fig. 10. Arthropod predator and detritivore abundances during 2013 – 2015 associated with either NRCS Sage-grouse initiative grazed or deferred pastures or the Lake Mason National Wildlife Refuge where grazing has been absent for over a decade.

Fig. 11. A Wolf Spider, Family Lycosidae

Fig. 12. A Clown/Hister Beetle, Family Histeridae

b) the relative abundance and diversity of above ground and plant-dwelling arthropods at sage-grouse nesting and songbird survey locations.

Samples are being processed. Anticipated completion date of June 1, 2017.

c) the relative abundance and diversity of wild pollinators.

Sample processing is nearing completion. Anticipated completion date of May 15, 2017.

d) the relative abundance and diversity of dung beetles.

Some of the arthropods considered food items of sage grouse are also dung feeding insects. Our sampling thus far has captured more dung feeding insects on the LMWR than on lands enrolled in the NRCS SGI (Fig. 13). Dung beetles, which are considered food items of sage-grouse, are dung obligates due to the nutritional needs of the larvae. Adults will mate and provision their offspring with a dung ball on which to feed and develop. It is unclear at this point why we have recorded more dung beetles on the LMWR, where cattle are absent, compared to active cattle ranches; however, pesticide residues in the manure may be playing a role.

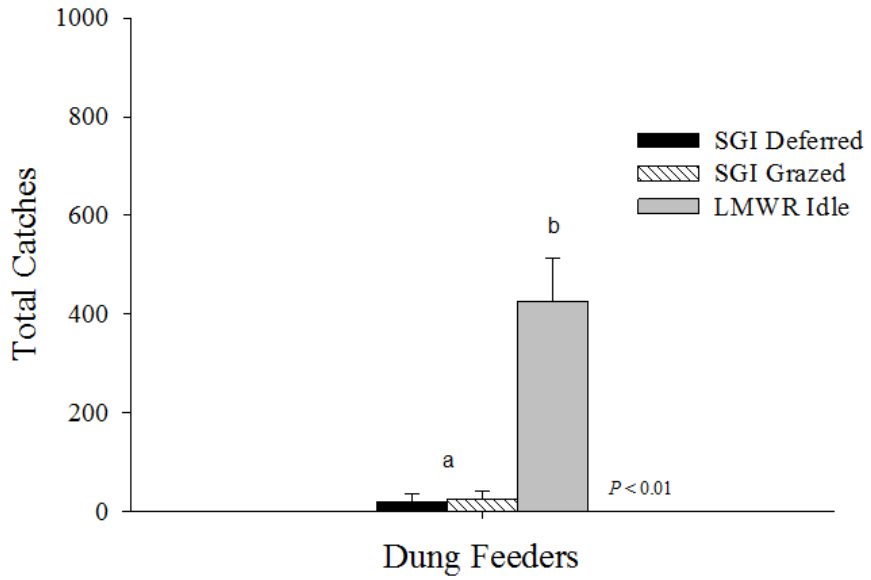

Figure 13. Dung feeding insect captures associated with the NRCS Sage-Grouse Initiative enrolled pastures and Lake Mason National Wildlife Refuge lands where grazing has been absent for over a decade. Ironically, dung feeding insect numbers are greater on lands where large mammalian herbivores are absent and may be a result of pesticide residues in cattle dung.

e) the vegetative community biomass and diversity and percent bare ground (so that we have vegetative data specific to our sampling locations which will complement other veg data).

Vegetative community metrics have been collected at all 2016 locations and are in the data analyses phase.

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